

Statement
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Hearing on University Resources for the Future of Nuclear Science and Engineering
Programs
Before the Energy Subcommittee, House Committee on Science
10 June 2003

Chairwoman Biggert, Mr. Lampson and members of the Committee, thank you for the opportunity to provide your committee with some information and perspectives about the *Future of University Nuclear Science and Engineering Programs*. This topic is the central concern of the Nuclear Engineering Department Heads Organization (NEDHO), which I chaired until last week. This organization includes the Heads and Chairs of all of the nuclear engineering departments in the US, and broadly represents our common interests to see the nuclear engineering discipline flourish at universities. I am also speaking from my personal interests as the Head of the Department of Nuclear, Plasma and Radiological Engineering at the University of Illinois at Urbana Champaign. It is the single department of nuclear engineering in Illinois, the most highly nuclear state in the US, and the home of the first man-made reactor.

The timing of this hearing is particularly opportune since there are several forces interacting currently to focus attention on the need to support and grow university programs in nuclear science and engineering. These forces include several recent positive developments:

- The regrouping of nuclear power utilities under deregulation to provide a strong and sustainable nuclear power generation infrastructure;
- nuclear plant license extensions – several nuclear plants have or will apply for extension of up to 20 years in their operating license;
- power up-rates of several existing nuclear power reactors to increase overall nuclear generated electricity;
- new nuclear power reactor designs – both abroad and at home, new and future generations of nuclear plants are under active development. The long-term focus of the Generation IV (Gen IV) reactors is headed toward new, more efficient, more passively safe, and secure reactors;
- new waste-efficient and proliferation-resistant nuclear fuel cycles – developments are underway to support “high burn-up” fuels and the Advanced Fuel Cycle Initiative (AFCI) to develop new fuels and fuel cycles which reduce waste and deter the build up of undesirable side products;
- continuing and growing interest in nuclear fusion – the US is now committed to a burning plasma experiment and is negotiating to rejoin ITER (one of the options for a burning plasma experiment);

- nuclear medicine – nuclear diagnostic techniques, radioisotopes, and a variety of nuclear-based imaging modalities are in increasing use to provide safe, effective medical procedures;
- movement forward with management of current nuclear waste at Yucca Mountain – the license process for Yucca Mountain is underway following the recommendation by the President and the assent of Congress last year;
- positive steps toward new civilian nuclear plant construction – the DOE and others are supporting an initiative for new nuclear plant construction in the “2010” Program. A few utilities have started inquiries for site approval as a first step toward new construction;
- Broad-based research initiatives for improving and advancing nuclear power facilities and operation for example through the Nuclear Energy Research Initiative (NERI) and the international version, INERI;
- increased awareness of the impact of carbon-containing emissions – the growing public awareness of the role nuclear power can play in reducing carbon-containing and other environmentally unfriendly gases;
- national and international security – the growing need for enhanced national and international security through the National Nuclear Security Administration (NNSA) and a broad range of activities to monitor and uncover dangerous nuclear agents;
- space nuclear power – the development of a nuclear power base for manned missions to Mars and beyond where nuclear-based propulsion is the only way to provide sufficient continuous power to keep flight times short and mission goals manageable;
- and the emergence of a balanced National Energy Policy – a balance approach to the development of a variety of energy resources in which nuclear power plays a central and long-term role. In addition, the trend toward a hydrogen-based fuel economy will certainly include nuclear power generation.

These positive trends have refocused the national outlook on the important and broad role nuclear technology and techniques can play in meeting our societal needs. The role of government has been critical in shaping and supporting many of these positive trends.

These positive dynamics are balanced by several concerns which present major challenges to further development of nuclear power and technology. These include:

- an aging nuclear workforce;
- pressures on nuclear academic programs and university research reactors, pressures that are increasing now in times of tight university budgets;
- lingering public perception of nuclear power, nuclear waste and international nuclear security;
- and difficulties in the emergence of a competitive nuclear utility industry through deregulation.

In fact, both the positive aspects and the challenges have been helpful in bringing a new generation of students to study nuclear science and engineering. These students are

buoyed by the positive trends in the nuclear industry and are willing to accept the challenges that lie ahead. These students see a meaningful and rewarding future in the nuclear engineering profession due to the expanding and long-term opportunities that the field now offers. This is a real turn around from the low enthusiasm and enrollments of the 1990's, a difficult period not only for the nuclear industry, but also for university degree programs and university reactors. This period saw the continued decline of several nuclear engineering departments and academic programs, and the loss of several critical university-based teaching, research and training reactors. This decline is still underway despite the current upward enrollment trends and increased research support for nuclear engineering programs. Two of the most recent serious concerns are the impending closing of the Ford Nuclear Reactor at the University of Michigan (the reactor I used in my undergraduate studies in Nuclear Engineering) and the moves to terminate my department at the University of Illinois and change its status to a program, or to disperse the faculty and program altogether. I will return to these points later, but it is important to note that these are major issues at two of the largest and best science and engineering universities in the country, and will have broad, negative impact.

There are currently 17 ABET accredited BS degrees in Nuclear Engineering, and one accredited MS degree program. This number has declined in recent years and can be contrasted to 295 BS degree programs in Electrical Engineering and 250 BS degree programs in Mechanical Engineering. Table 1 shows an indication of the engineering BS degree types at the top ten graduate colleges of engineering. Note that Nuclear Engineering is a prominent degree program at many top institutions. Nevertheless, at least two of the existing BS programs are under severe pressure and may not survive. These are the program at the University of Maryland and my program at the University of Illinois, as mentioned above. Several features of nuclear engineering educational programs are noteworthy and indicate the need for specific, focused attention to the well being of the discipline:

- Nuclear engineering is a unique discipline – it is not a sub-discipline of other traditional engineering fields, making it difficult to impossible to flourish as sub-discipline in another department.
- Many nuclear engineering programs which were merged into other engineering departments have dwindled or are completely gone.
- The nuclear discipline is new – the first reactor was assembled in Chicago just over 60 years ago, and many nuclear engineering programs were formed starting in the late 1950's to early 1960's to educate a new generation of students for a variety of nuclear applications.
- Nuclear is “high tech” – the discipline requires strong math, science and technical skills so nuclear engineering programs are found at the best universities and attract the best students, students who, on graduation, attract the best salaries in the short and long term and who have the highest average passing scores on the professional engineering exams.
- Nuclear programs are under pressure due to the low enrollments during the 1990's and needs to redistribute resources to other academic areas. This is exacerbated by current, severe university budget pressures.

- The resurgence of the nuclear engineering profession has prompted the formation of new programs and departments – the most recent are BS programs at South Carolina State and at the US Military Academy, and MS programs at the University of South Carolina and at the University of Nevada at Los Vegas. The development of new programs requires extensive new resources to be successful. Thus these programs should be seen as complementary to the existing programs, and serve to further emphasize the value of the existing nuclear degree programs.

The situation for university research reactors is no better. The current number of university research reactors (URR) is 27, down from a high of 65. Furthermore, the losses of have not been orderly. Several of the largest, most well maintained reactors have closed due to local university pressures. My reactor at the University of Illinois is among this group. We closed in 1998 due to a local administrative decision not to relicense one of the top few reactors in the country, our Advanced TRIGA Reactor, the last research reactor in the State of Illinois. Nor have these closures been systematically planned since several of the best reactors have been shut down due to local pressures, rather than some view to national needs. The DOE recognized the need to better support these national assets and instituted a few directed studies which led to the development of the in Innovations in Nuclear Infrastructures and Education (INIE) Program last year. This program is aimed at providing the support base to maintain a national university research reactor program with coordination between participating universities, national laboratories and industry. In a highly competitive process, four reactor consortia were funded last year, and two more consortia will be added this year. This effort came too late to help reactors which closed in the 1990's, including mine, and could not influence more recent closures at Cornell and an impending closure at the University of Michigan. Other reactors, including some in existing consortia, are still at risk. Table 2 provides an indication of which of the current largest university research reactors are included in INIE consortia. (My reactor is in SAFSTOR, but its prominent position on the list indicates the magnitude of its loss to our program.) The INIE program, as the Table only partially indicates, has led to wide partnering between universities to share reactors, reactor technology and reactor resources. Partnering on this scale has not been seen before, and has broad benefits for sharing teaching and outreach resources which can only strengthen the nuclear discipline in general, while also supporting a diminished, but necessary, fleet of university reactors. An indication of the

The DOE has taken several other critical steps to directly support university degree programs, including the Nuclear Engineering Education Research (NEER) Program, the DOE-Industry Matching Grant Program, and several Fellowship and Scholarship programs. These are in addition to university participation in other, broader research programs supported by DOE-NE and other DOE offices. Dr. Marcus will describe these in much more detail in her testimony, so I will not delineate them further here. These programs have been critical to the well being of university program. They have been offered on a competitive basis with highly focused peer review processes to determine and award only the very best proposals. Both the resources and the competitive nature of the award process have strengthened university degree programs. These programs have also been important in developing and strengthening ties between research programs at

universities, national labs and with the nuclear industry. Nevertheless, these programs remain under-supported. For example, more than half of the NEER grant applications are worthy of funding. In a good year, less than 20% will receive funding, and this year less than 10% of the new grant applications were funded. In addition, only one new DOE-NE Fellowship will be awarded this year.

These efforts are critical for supporting nuclear programs, but challenges remain. For almost all university programs, resources are based on undergraduate enrollments. The decade of low undergraduate enrollments in the 1990's has compromised the position of many nuclear engineering departments. We need to continue to address the undergraduate enrollment issues for a number of reasons – the most important are the need to cultivate a highly-qualified and well-educated group of nuclear engineers to meet national manpower requirements. Increases in undergraduate student enrollments to meet this need will also restore the strength of the departments at universities. These manpower requirements are widespread – at national labs, at utilities, at nuclear vendors, and at nuclear utilities. The time line to the biggest impact differs between industry sectors, but it is clear that the future well-being of the industry rest entirely on attracting and educating new students. Even in sectors where the manpower needs are further in the future, for example, the nuclear utilities, they will need an extremely well educated workforce to provide them the edge they need for the competitive markets they are entering, and to maintain secure and safe operation. In the nuclear defense sector, international security issues demand a highly educated and highly dedicated workforce to replace the currently aging experts. The success in every sector of the nuclear enterprise will depend on the quality and education of the people they hire. This underlines the continuing, acute need to support the nuclear education infrastructure in the US.

In this regard, my situation at the University of Illinois is instructive, and foreboding. My Department is under pressure to be merged with another department or to be dispersed altogether. This is despite strong increases in research funding and moderate, but steady increases in undergraduate student numbers, and very high national ranking and reputation. This problem is exacerbated by the faculty age distribution – we, too, have a major issue with an aging work forces, common to many university nuclear programs. The average age of my faculty is over 56 years, with three of the nine faculty members at age 70 or more. The older faculty members represent a wealth of knowledge in the nuclear field dating back nearly to the beginning. In fact, one of these faculty members is the first PhD in Nuclear Engineering awarded in the US. Nevertheless, my Dean is looking to redistributing resources in the College of Engineering and, in the process, to merge or disband my Department. This problem is related almost solely to our low undergraduate enrollment numbers. At a time when we should be building for the future with the rest of the country, we are fighting for existence. This is particularly alarming for us. We are the only nuclear engineering department in the State of Illinois, a state with 11 operating nuclear power reactors (and associated spent fuel), Argonne National Laboratory, and other nuclear facilities. Illinois residents have paid more than \$2.4 billion into the federal Nuclear Waste Fund. Our program has contributed widely to the state and national nuclear infrastructure that supports nuclear power, technology and national security. It is hard to accept that a State with such a large stake in nuclear power

and technology cannot support a Department of Nuclear Engineering and the necessary ten to twelve faculty members. This picture may be extreme compared to situations elsewhere where undergraduate enrollments have climbed more quickly than ours, but it is a warning about how fragile the nuclear engineering educational infrastructure remains in the US, particularly in times of tight state and university budgets. Action is required to support and maintain these valuable programs.

In conclusion, the government has played the key role in defining and supporting nuclear development in the US, an area which, in many aspects, the US continues to lead. The globalization of much of the nuclear reactor design and support activities leaves the US as a major player, at least. In other areas, which directly impact national and international security (both in defense and energy self-sufficiency), and in areas of advanced nuclear systems design, in nuclear fusion, in nuclear medicine, and in nuclear space applications, the US maintains, and must protect, its leadership role. The nuclear educational infrastructure in the US has maintained its international leadership role: the US universities are still the best place in the world to learn nuclear science and engineering. This educational leadership must be maintained as THE necessary means for keeping all of the other sectors in the US nuclear portfolio vital and vibrant.

Several positive steps have been taken to support and grow the university nuclear education and nuclear reactor infrastructure. Further steps are necessary. These include:

- Steps which lead to supporting the NERAC recommendation of a funding level of \$33M for nuclear university programs;
- Full and continuous funding for the INIE program to support university research reactors;
- Support for enhanced interactions (intellectual and financial) among universities, national laboratories, and industry;
- Better national liaison with universities to underline the national, as well as local, importance of a strong nuclear education and reactor infrastructure, particularly to protect and enhance existing programs, and to provide opportunities for new programs; and
- Continued support of efforts to establish a new nuclear plant order in the US – this is seen almost universally as a national commitment to nuclear power and is likely to attract many new students to the discipline.

Thank you for your attention and interest.

Answers to Specific Questions (in addition to comments in the body of the Statement)

- What were the most important recommendations the Nuclear Engineering Department Heads Organization (NEDHO) recently made regarding DOE's university nuclear science and engineering programs? What are the implications for the health of university nuclear science and engineering programs and for the

nuclear power industry if DOE were to fall short of implementing those recommendations?

NEDHO has supported a request for increasing funds in the DOE-NE support for University Nuclear Science and Engineering Programs, designated in the DOE-NE budget as University Reactor Fuel Assistance Support (URFAS). We support a funding level of \$26.5 for FY04, an increase from \$18.5M, with priorities given to, in order, increase INIE to nearly full funding (\$11M from 6.5M), increase NEER (\$8M from \$5M), and increase Fellowships (\$1.9M from \$1.5M). These increases will support the necessary growth of the university programs. In the longer term, we support the recommendations of NERAC (Nuclear Energy Research Advisory Committee to DOE-NE) to increase URFAS to reach a level of \$33M, with appropriate increases in several categories including those mentioned above. Without these resources, several programs would come under severe risk of merger or closure. Stability of research and infrastructure support, through DOE and others, remains a critical issue in the health of US nuclear engineering programs. One only needs to reflect on the dire situation in the mid-1990's when the university support was zero, to see the lasting impact of funding shortfalls and instability of support.

A specific justification of the requested increases for FY04 are included here as an appendix

- To what extent is the existing university nuclear infrastructure, including nuclear research reactors, sufficient to maintain a vibrant nuclear research enterprise the United States? To what extent is it sufficient to provide the workforce training and research opportunities necessary to sustain the nuclear power industry and provide for other societal needs into the future?

We feel that the nuclear infrastructure needs to grow to meet the increasing and lasting need for nuclear-educated professionals. However, first we need to commit to supporting the current number of excellent nuclear science and engineering educational programs, many of which are still struggling for resources in an increasing competitive atmosphere in under-funded university programs. This includes a commitment to replace aging faculty to maintain the important collective knowledge that will soon be gone. We also support the development of new programs, there are some recent examples, since the workforce issue will not diminish. Finally, almost all nuclear programs are increasingly using distance education techniques to reach wider audiences more quickly and efficiently. This technology can also be used to capture the wisdom of the more senior university faculty before they leave the system completely. In order to accomplish all of this, we require the substantial and continued support of the government.

- To what extent does the quality of a university's nuclear science and engineering program depend upon the university having a nuclear reactor? To what extent can the national laboratories and industry support university programs?

There are several aspects to maintaining high quality educational programs, and facilities, including university research reactors, are an important part of the picture. As indicated above, nuclear programs are found at the leading science and engineering universities. This is due in no small part to the high degree of science and mathematical skills required of student of the discipline. Our degree programs are able to maintain high academic standards in the absence of a reactor, but clearly reactor experience can be a defining event for student development. In the past year, the founding of the INIE program will provide for wider research reactor experience for students at universities without reactors (as well as many in other disciplines and other educational levels). We think this will have a very positive effect on maintaining the quality of nuclear engineering education. While remote access to reactor technology is helpful, the INIE, and earlier the “Reactor Sharing” Program, provide a mechanism for visits and research experiences on an existing reactor. National labs and industry have been supportive of reactor experiences for students when practicable. There are relatively few national lab reactors, and access to industry based power reactors is difficult. The nuclear industry has participated broadly in making their reactor simulators available for educational purposes. In addition, there is significant partnering with national labs and industry in the INIE program (as well as NERI, etc.) which support more expansive use of valuable reactor facilities.

National lab and industry interaction and support of university nuclear programs is critical in a very broad sense. There are many long-standing interactions of this sort which have resulted in graduate student experiences at national labs, and a variety of internships for undergraduate students at utilities and at national labs. In the research area, many of the most successful exchanges are done on an individual basis. Cooperative research through NERI, AFCI and partnerships within INIE have also been important in enhancing university-national lab-industry interactions. We support further considerations now underway at DOE-NE to provide better and more plentiful means of participating intellectually and financially in funded research at national labs, and with industry where appropriate. We feel that many of the current national nuclear initiatives will not succeed without strong university-national lab-industry cooperation.

Table 1. ABET Accredited BS Degree Programs at Top Ten Engineering Schools, USNWR 2003 and ABET

School	EE	ME	CE	ChE	CpE	IE	AE	MSE	AgE	Nucl	EM	GE	Eniv	Bio	Total
MIT	♦	♦	♦	♦	♦		♦	♦		♦			♦		14 ^a
Stanford	♦	♦	♦	♦		♦									5
UC–Berkeley	♦	♦	♦	♦	♦	♦				♦					7
UIUC	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			12 ^b
Georgia Tech	♦	♦	♦	♦	♦	♦	♦	♦		♦			♦		11 ^c
Michigan	♦	♦	♦	♦	♦	♦	♦	♦		♦					10 ^d
Cal Tech	♦			♦											3 ^e
USCal	♦	♦	♦	♦		♦	♦						♦		7
Purdue	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			♦	*	13 ^f
UT - Austin	♦	♦	♦	♦	♦		♦			†			♦		10 ^g
Totals in top 10	10	9	9	10	7	7	7	5	2	6	1	1	4	0	
Totals in US	295	250	228	155	139	100	65	42	41	16	8	1	34	25	

* Purdue has an accredited BS degree in “Agricultural and Biological Engineering”

† U Texas – Austin has a Nuclear Engineering Option in its ME programs

Additional Degree Programs

^a Ocean Engineering, variations on standard BS degree names

^b EM – Engineering Mechanics, GE – General Engineering

^c Textile and Fiber Engineering

^d Naval Architecture and Marine Engineering

^e Engineering and Applied Sciences

^f Construction Engineering, Food Process Engineering, Land Surveying

^g Architectural Engineering, Geosystems Engineering, Petroleum Engineering

Sources: http://www.abet.org/accredited_programs/EACWebsite.html
http://www.usnews.com/usnews/edu/grad/rankings/eng/brief/engrank_brief.php

Table 2
Status of the Largest University Research Reactors and INIE Funding
Shaded Facilities Are Included in an Existing or Likely INIE Consortium

Location	Type	Power -kW	Criticality Date	Status	Comments
U of Missouri-Columbia	Pool. LW mod	10,000	Oct-66	Operating	
MIT	Tank, LW mod, HW Refl	5,000	Jul-58	Operating	License renewed in 8/99
UC-Davis	TRIGA Mark II	2000		Operating	Acquired from McClellan AFB
U of Michigan (a)	Pool. LW mod	2,000	Sep-57	Operating	
<i>U of Illinois (b)</i>	<i>TRIGA</i>	<i>1,500</i>	<i>Jun-61/Jul-69</i>	SAFSTOR	<i>Operating License Expired 8/1998</i>
U Texas-Austin	TRIGA Mark II	1,100	Mar-92	Operating	
NC State	Pulsar	1,000	Jan-72	Operating	Received new license – 4/97 for 20y
Oregon State	TRIGA Mark II	1,000	Mar-67	Operating	License renew 2006
Penn State	TRIGA, Conversion Mark III	1,000	Aug-55	Operating	License renew 2005
Texas A & M	TRIGA Conversion	1,000	Jan-62	Operating	License renew-2003
U Mass-Lowell (c)	Pool, LW mod, Graphite refl.	1,000	Jan-75	Operating	License renew 2015
U of Wisconsin	TRIGA Conversion	1,000	Mar-61	Operating	License renewed - 2000
Washington State	TRIGA Conversion	1,000	Mar-61	Operating	License renewed - 2002

Notes:

- (a) Scheduled to be shut down 3 July 2003
- (b) Shut Down Aug 1998 – SAFSTOR with a possession only license, all facilities still on site
- (c) Will likely join the MIT-based INIE consortium

Appendix: FY04 Funding Request for the University Nuclear Science and Engineering Programs

James F. Stubbins, John C. Lee, Andrew C. Klein, and Michael L. Corradini
Nuclear Engineering Department Heads Organization

The FY04 Department of Energy funding for the University Reactor Fuel Assistance Support (URFAS) Program is inadequate to meet our nation's critical need for university-based nuclear education and research. The URFAS Program is the primary source of funding for the university nuclear science and engineering (NSE) educational programs and university research reactors (URRs). This testimony presents the unanimous position of both the Nuclear Engineering Department Heads Organization (NEDHO) and the National Organization of the Test, Research, and Training Reactors (TRTR).

Key Issues and the Request

The U.S. has become keenly aware of the importance of secure and affordable energy supply for the present and future well-being of the nation. Nuclear energy can play a crucial role in stabilizing and reducing energy prices, and in meeting the energy needs of the country by the production of electricity as well as hydrogen for transportation. This has been emphasized in recent Congressional bills and in speeches by Secretary Abraham and President Bush. Significant concerns have been raised, however, regarding the maintenance of the workforce required to retain our nation's nuclear energy option. Grossly inadequate student enrollments in NSE programs, despite modest improvements over the past few years, and imminent threats to continued operation of URRs are primary concerns that need to be addressed immediately.

Despite these escalating problems, the FY04 DOE request of \$18.5M remains flat at the FY03 appropriation and is significantly below the \$33M recommended in the Energy Research, Development, Demonstration, and Commercial Application Act of 2003, H.R.238. In light of the severe budgetary constraints anticipated for FY04, we respectfully request:

The House and Senate Energy and Water Appropriations Subcommittees appropriate for FY04 \$26.5M for the University Reactor Fuel Assistance Support Program within DOE's Office of Nuclear Energy Science and Technology Programs.

This represents a modest increase of \$8.0M from the FY03 appropriation and is required to prevent further declines in the URRs and university NSE programs. A detailed breakdown for the FY04 funding request for the university NSE programs is given in Table I below.

Table I. FY04 Funding Request for the University NSE Programs

Budget Category	FY02	FY03	FY04 (DOE request)	FY04 (needed)
Fellowship	1.4	1.4	1.4	1.9
Nuclear Engineering Education Research	5.0	5.0	5.0	8.0
Other academic programs	1.3	1.3	1.3	1.3
Reactor fuel, instrumentation, and sharing	4.3	4.3	4.3	4.3
Regional URR centers (INIE)	5.5	6.5	6.5	11.0
Total Funding (\$M)	17.5	18.5	18.5	26.5

NEDHO and TRTR unanimously agree that the FY04 funding request should be, in order of priorities: (1) Innovations in Nuclear Infrastructure and Engineering (INIE) program increase of \$4.5M to a total of \$11.0M, (2) Nuclear Engineering Education Research (NEER) program increase of \$3.0M to \$8.0M, and (3) fellowship and scholarship program increase of \$0.5M to \$1.9M.

Justification for the Request

The Nuclear Energy Research Advisory Committee (NERAC) to the Secretary of Energy discussed in a recent report the importance of academic NSE programs in meeting the infrastructure and workforce requirements for sustained nuclear technology development related to (a) current and future generations of nuclear power plants, (b) radiation sciences with industrial, medical, and biotechnology applications, (c) national security and weapons nonproliferation programs, and (d) nuclear propulsion in the U.S. Navy. This NERAC report highlights the near-crisis status of the country's NSE programs, noting that over the past two decades the number of academic nuclear engineering programs has halved to the current total of only 25, with a similar decrease in the number of URRs from 65 to 26.

In light of the decision by Cornell University in 2001 to decommission its campus reactor and the imminent risk to the URRs at the University of Michigan and Massachusetts Institute of Technology, DOE initiated in 2002 the INIE program to support regional URR centers. Seven regional URR consortia, distributed across the country, were selected through an independent peer review panel for funding. Due to the limited FY02 INIE appropriation of \$5.5M, DOE was able to provide funding only for four consortia, with the three additional consortia to receive INIE grants as additional funding becomes available. In the FY03 omnibus appropriations bill, the INIE funding is increased only by \$1M to a total of \$6.5M, despite a funding request of \$8.5M in the Senate appropriations bill. With this limited INIE FY03 appropriation, DOE would be unable to initiate funding for the remaining three URRs selected, but not funded to date. Without increased INIE funding the University of Michigan will shut down and decommission its reactor due to inadequate external financial support. The current INIE appropriation provides only partial funding even for the four URR consortia already funded. Our requested FY04 INIE funding of \$11M provides the minimum support required to initiate funding for the three remaining consortia and sustain a total of seven URR regional centers distributed across the country. The lead institutions for the seven URR centers selected for funding are as follows:

1. Massachusetts Institute of Technology
2. Pennsylvania State University
3. Oregon State University and University of California, Davis
4. Texas A&M University
5. University of Missouri, Columbia
6. University of Michigan
7. North Carolina State University.

The seven consortia involve participation by at least 15 other universities and several national laboratories. Because these URRs belong to the group of best-utilized facilities, and are associated with the top nuclear engineering departments in the country, a premature demise of any of these leading URRs would be a major blow to the nation's nuclear energy program and the loss of valuable national scientific research and training resources. This loss would be tragic particularly as the nation begins to actively consider expanding nuclear electricity generating capacity to meet the increasing energy demand for the nation. Because contributions of nuclear scientists and engineers extend well

beyond traditional nuclear power, including national defense, homeland security, medical applications of radiation science, and industrial applications, the shortage of technically trained nuclear professionals is even more critical.

A recent NEDHO study² indicates that the annual demand for nuclear engineers is expected to exceed the supply by 400 in the immediate future. This shortage of nuclear engineers is due primarily to the retirement of the first generation of engineers engaged in the development, construction and operation of current generation of 105 nuclear power plants operating in the country. This shortage has resulted in a very tight job market for employers seeking nuclear engineers and a number of utilities are investigating programs to train non-nuclear engineers to work in the nuclear fields. With a number of U.S. utility companies establishing plans to order new nuclear power plants in the very near future, however, the demand for nuclear engineers will grow and the nation's ability to expand nuclear electricity generating capacity may likely be limited by the trained workforce, not by the financial resources.

In addition to the urgent funding increase for the INIE program discussed above, we offer comments on various budget categories for the proposed university NSE funding:

- The NEER program, since its inception in the current form in FY98, has been a major source of research funding for the entire academic NSE community and has contributed significantly to our ability to attract quality graduate students into research programs. These research grants cover areas of basic nuclear science and engineering research and synergistically augment much more application-oriented programs funded through the Nuclear Energy Research Initiative (NERI). The NEER funding has been flat for the past five years at \$5.0M, supporting only one out of every ten competitive proposals in a given year. Thus, the proposed increase of the NEER funding from \$5.0M to \$8.0M is very much needed, although still insufficient to fund many of the research proposals that are highly evaluated but not supported due to limited funding. The NEER grants have been and will continue to support research programs not only in nuclear science and engineering but also in related fields of health physics and radiation safety. An increased FY04 appropriation for the NEER program will be especially necessary for this purpose.
- Funds for undergraduate scholarships and graduate scholarships are essential in our effort to increase student enrollments in nuclear engineering and related programs. Although the DOE fellowship funding has been highly valuable, the funding level has remained flat for the six years and woefully inadequate. To simply illustrate the inadequacy of \$1.4M fellowship support in the FY04 DOE request, we note that it requires up to \$55,000 per year to support a graduate student at many research universities.
- The other academic programs for a total of \$1.3M include the DOE/Industry Matching Grants, which leverage the DOE funding for broad-based support from the nuclear industry for the university NSE and URR programs. Many schools use the Matching Grants to augment the DOE fellowship funding for undergraduate scholarships and graduate student research support. The remainder of the \$1.3M funding will support a modest program in radiochemistry and facilitate closer collaborations in research and instructional programs between DOE national laboratories and academic institutions. The funding will also promote community outreach effort including the training of high school teachers in nuclear science and technology.
- The remaining \$4.3M funding for the URRs cover the costs for (1) supply of fresh reactor fuel and shipment of irradiated fuel, (2) refurbishment and upgrade of

instrumentation primarily for URRs not included in the INIE consortia, and (3) providing URR access to researchers at universities without a campus reactor.

- University research reactors provide essential support both for instructional and research programs on 26 university campuses. These campus reactors offer programs in (a) incore irradiations for materials science study, isotope production in medical and industrial applications, neutron activation analysis in manufacturing and environmental applications, and nuclear wasteform study, (b) neutron beam port applications for neutron scattering as a materials diagnostic tool, neutron radiography as a nondestructive testing tool, semiconductor processing, characterization of materials in nuclear and non-nuclear applications, and boron neutron capture therapy, (c) reactor control study involving digital instrumentation and control for advanced reactors as well as for the current generation of nuclear power plants, (d) neutron and reactor physics studies offering research in medical imaging, radiation detectors for homeland security, nuclear fuel development, and advanced reactor design and safety features. In addition, each URR serves as a magnet for recruiting students and is a focal point for community outreach.

Summary of the Request

We respectfully request that Congress provides in the FY04 budget \$26.5M for operations and research support for university research reactors and research and student support of the nuclear science and engineering departments. This amount will fund the seven INIE regional reactor centers and strengthen academic programs in nuclear science and engineering. This funding level is required to guarantee the nation secure energy sources for the future and enhance the scientific, medical, and industrial applications of radiation science and technology for the nation.

References

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